Epitomes

Important Advances in Clinical Medicine

Nuclear Medicine

The Scientific Board of the California Medical Association presents the following inventory of items of progress in nuclear medicine. Each item, in the judgment of a panel of knowledgeable physicians, has recently become reasonably firmly established, both as to scientific fact and important clinical significance. The items are presented in simple epitome and an authoritative reference, both to the item itself and to the subject as a whole, is generally given for those who may be unfamiliar with a particular item. The purpose is to assist busy practitioners, students, research workers or scholars to stay abreast of these items of progress in nuclear medicine that have recently achieved a substantial degree of authoritative acceptance, whether in their own field of special interest or another.

The items of progress listed below were selected by the Advisory Panel to the Section on Nuclear Medicine of the California Medical Association and the summaries were prepared under its direction.

Reprint requests to Division of Scientific and Educational Activities, California Medical Association, PO Box 7690, San Francisco, CA 94120-7690

Radionuclide Scrotal Imaging

A RELATIVELY ABRUPT onset of painful swelling of the scrotal contents is commonly caused by either torsion of the spermatic cord or epididymo-orchitis. Torsion requires prompt restoration of blood flow, usually by surgical means, to salvage the compromised testis. Bilateral orchiopexy is also indicated to provide anchorage of the testes to the scrotum. Epididymo-orchitis usually responds to antibiotic therapy. The surgical salvage rate of about 50% in torsion depends greatly on the degree of ischemia and the time elapsed between onset and correction of the ischemia.

Radionuclide scrotal imaging provides a rapid cost-effective means of accurately distinguishing between an essentially avascular process, such as spermatic cord torsion, and a hyperemic process such as epididymo-orchitis. In several combined series, the sensitivity of properly done radionuclide scrotal imaging for detecting acute spermatic cord torsion is 93% or greater, which exceeds clinical sensitivity. Most likely to be missed by this technique are torsion in the newborn period and so-called missed torsion in which prolonged ischemia of more than 24 hours' duration has provoked hyperemia in the surrounding scrotum. In most cases, the testis undergoes infarction.

Other processes such as hydrocele, hernia, hematoma and testicular necrosis from a variety of causes appear avascular and can mimic the appearance of spermatic cord torsion. Nevertheless, the specificity of the technique is also high, enabling the diagnosis of torsion of the spermatic cord to be excluded in 93% of other conditions. This spares a patient an unnecessary surgical procedure and expense. The technique is less useful for distinguishing causes of nonacute scrotal masses that may be better sorted out by methods, such as ultrasonography, which characterize tissue densities.

Radionuclide scrotal imaging commonly shows ischemia of the involved testis in men with infertility due to varicocele. Another approach, that of imaging of the blood pool of the scrotal contents with the patient's erythrocytes labeled with technetium 99m, has proved more useful in identifying the varicocele itself. In some cases this technique will define subclinical varicoceles. A similar approach has been used with good results to separate impotence due to vascular insufficiency from other causes.

FRED S. MISHKIN, MD
Los Angeles

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Multiple-Gated Equilibrium Radionuclide Ventriculography to Assess Heart Function

MULTIPLE-GATED EQUILIBRIUM radionuclide ventriculography is a relatively noninvasive method for evaluating global and regional right and left ventricular function. Erythrocytes are labeled with technetium 99m. A patient's electrocardiogram is recorded while labeled blood in the right and left ventricles is imaged in at least three projections—such as anterior, 30° to 40° left anterior oblique and left lateral—using a standard gamma scintillation camera. The cardiac cycle is divided into 16 to 32 equal time frames which are displayed in a movie format. Left ventricular ejection fractions are calculated from the left anterior oblique view and correlate well with those by contrast ventriculography. Additional indices obtained with this technique include left ventric-

ular volumes, indices of systolic function, such as first-third ejection fraction and average or peak ejection rate, indices of diastolic function, such as peak filling rate and the time to peak filling rate, and the temporal sequence of ventricular wall motion by phase analysis, which aids in assessing asynchrony of wall motion and of conduction abnormalities. Right ventricular function can be assessed most accurately by gated imaging of a radionuclide bolus transit through the right side of the heart.

This test provides useful information in a variety of clinical situations. Evaluation of right ventricular function at rest is helpful in patients with diseases such as right ventricular infarction, obstructive lung disease, pulmonary hypertension, right-sided valvular heart disease and congenital anomalies. Evaluation of global and regional left ventricular function at rest can provide baseline information in patients with cardiomyopathies and valvular and congenital disease, and aids in monitoring results of surgical procedures and of intravenously given drugs, including the cardiotoxic effects of chemotherapeutic agents, such as doxorubicin (adriamycin) hydrochloride. In addition, prognostic information can be obtained in patients with acute myocardial infarction. Detection of tricuspid regurgitation and of anatomic abnormalities such as true or false left ventricular aneurysm, left ventricular thrombus, atrial myxoma and aortic coarctation is also possible.

Comparison of left ventricular function at rest and during upright or supine bicycle exercise is highly sensitive in diagnosing significant coronary artery disease, enables evaluation of functional reserve in myocardial and valvular disease and may aid in optimum timing of surgical intervention in patients with valvular disease. The response to exercise in men is considered abnormal if any or all of the following occur: the global ejection fraction increases less than 0.05 ejection fraction units, end-systolic volumes increase or fail to decrease or there are new wall motion abnormalities. Healthy women may respond to exercise without the ejection fraction increasing due to an increase in end-diastolic counts. Therefore, an abnormal response would consist of no change or a decrease in ejection fraction.

Exercise equilibrium radionuclide ventriculography is especially useful for detecting coronary artery disease; the sensitivity approaches 90%, although the specificity is only about 60%. This test is most helpful diagnostically in patients with a moderate probability of disease. In this patient population, an abnormal response makes the presence of coronary artery disease highly likely, whereas a normal response lowers the likelihood of significant disease. Therefore, normal results of an exercise test may lessen the need for proceeding immediately with invasive techniques such as coronary arteriography. Finally, the pattern of response to graded exercise aids in estimating the extent and severity of coronary artery disease. In summary, this relatively noninvasive radionuclide test is easy to do and provides highly useful diagnostic and prognostic information.

MALEAH GROVER-McKAY, MD
HEINRICH R. SCHELBERT, MD
Los Angeles

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Leukocyte Imaging for Detecting Acute Inflammatory Processes

INDIUM 111-LABELED LEUKOCYTES are widely used to diagnose acute inflammatory processes. Since its introduction nearly a decade ago, leukocyte scintigraphy has proved to be sensitive, specific and technically feasible for most nuclear medicine departments. In the past three years the indications, potential pitfalls and optimization of the study have been more clearly defined.

Leukocyte imaging has proved most effective in cases of acute inflammatory processes and abscesses (less than two to three weeks), inflammatory bowel disease and vascular graft infections and in patients postoperatively; it also appears efficacious in patients with acute osteomyelitis. A complementary rather than a primary role is suggested in renal, central nervous system, pulmonary and orthopedic diseases. Radioactive gallium is still recommended for chronic processes and computed tomography and ultrasonography in patients with localizing signs.

Pitfalls of the study include a reduced sensitivity in the first four to six hours after reinjection of labeled cells, demonstrated uptake in noninfected foci—such as recent hematomas, rarely in metastases and diffuse "inflammation"—investigational new drug status and the technical expertise necessary to label the leukocytes.

Alternative agents do not yet appear to offer significant advantages over oxine ^{111}In, although recent work has been reported with tropolonate ^{111}In and chloride ^{111}In. Prospects do appear encouraging for the development of an agent that will solve some of the major problems of labeled leukocytes—that is, kit preparation for rapid patient labeling, a drug that is noninvestigational and reliable results in hours rather than the next day. Studies are also in progress to assess the use of single-photon emission computed tomography to enhance diagnostic accuracy.

MICHAEL S. KIPPER, MD
Vista, California

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Evaluation of Gastric Emptying Rates

ABNORMAL RATES OF GASTRIC emptying, whether due to structural or to functional abnormalities, are particularly well suited for evaluation by nuclear medicine. It is often desirable to document, and if possible, quantify such abnormalities objectively because clinical complaints such as fullness may be hard to assess.

Gastric emptying mechanisms and rates differ for liquids and solids. Further, rates of liquid and solid emptying are related to the nature and amounts of materials consumed. Various tests have been used over the years to assess gastric emptying rates. For liquids, the saline load test is often used, which requires a nasogastric tube. Barium x-ray studies can